Thermodynamic Properties and Physical-Chemical Transformations of Polymer Materials at High Temperature and Pressure

K.V. Khishchenko, V.E. Fortov, and I.V. Lomonosov
High Energy Density Research Center
Russian Academy of Sciences
Izhorskaya Str. 13/19
Moscow, 127412, Russia

An adequate description of thermodynamic properties of materials over a wide range of parameters on the phase diagram is important for analysis of physical processes under extreme conditions of high energy densities. Shock-wave data for organic compounds indicates that these substances undergo physical-chemical transformations under the influence of the intense dynamic loading, resulting in properties of the denser state that differ appreciably from these observed under normal conditions. Traditionally this is explained by breaking of chemical bonds of the original compound, and the formation of a low-compressibility mixture of a diamondlike phase of carbon and various low-molecular weight components. It is characteristic for aromatic compounds that the transformation on the shock Hugoniots involves a significant change in the density (by ~20%) and compressibility of the medium.

In this paper, we propose a semiempirical model of equations of state for polymer materials, which takes into account the transformation of compounds at high dynamic pressure. Wide-range equations of state for some aromatic polymers, namely polystyrene, poly(m-phenilene isophthalamide), and polyimide, are constructed on the basis of the model developed, and the critical analysis of calculated results in comparison with the set of available at high energy density experimental data is made. The typical form of the phase diagram for aromatic substances at high temperature and high pressure is discussed.